Pyrenomycetes, but they were found in a very imperfect condition. Their occurrence was always merely local; they did not penetrate the entire tubercle, and the mycelium seemed constantly to decrease in size towards the center of the tubercle. Another fact observed was that the fungi only occurred in degenerated or decayed parts of the roots and tubercles. From this fact we might conclude that the fungi were saprophytic in nature, and had nothing to do with the malformation of the roots.

Comparing these tubercles with similiar ones on the roots of other plants, the author considers them to be nearly identical with those which Brunchorst described from *Cratægus prunifolia.*[2] The cause of their formation may be sought in purely external conditions, such as a sudden change in the nutrition of the plant or in some mechanical obstruction. In the present case it was found that the development of the tubercles was especially frequent whenever the roots struck sterile layers of sand, and they were thus at once deprived of their usual nourishment.—THEO. HOLM.

Studies upon galls.[3]

Pliny was the first to use the word gall (*galla*) as a name for these well-known outgrowths upon plants. The word has since been used for any pathological formation which appears as a thickening or swelling, and which is caused by insects, spiders, or fungi. The injury may, however, be of quite a varied character, and botanical terminology gives a large number of terms for distinguishing between the various forms, under which parasitism or pseudo-parasitism may occur.

Vuillemin[4] for instance has proposed the terms "antibiosis" and "symbiosis," according as the interference is or is not injurious to the host. But while this writer considers parasitism as intermediate between anti- and sym-biosis, Sarauw[5] uses parasitism as embracing all the various forms of anti- and sym-biosis.

The result of an antibiosis is probably always the develop-

[2]Brunchorst: Ueber einige Wurzelanschwellungen insbesondere bei *Alnus* und den *Elæagnaceen*. Untersuch. im bot. Inst. Tübingen 1885–88.

[3] Küstenmacher, Max: Beiträge zur Kenntniss der Gallenbildungen mit Berücksichtigung des Gerbstoffes. Pringsheim's Jahrb. f. wiss. Bot. **26:** —. 1894.

[4] Vuillemin, Paul: Antibiose et symbiose. Assoc. française pour l'avanc. des sciences. **18:** —. 1889.

[5] Sarauw, Georg F. L.: Rodsymbiose og Mykorrhizer. Bot. Tidsskrift. **18:** —. 1893.

ment of a gall, which, however, may show a marked difference in its exterior aspect and internal structure.

The cynips-gall may be taken as a good example. It is often globular and the anatomical structure shows the differentiation of two or more (frequently of three) concentric layers as follows: 1. The parenchymatic outer layer with epidermis, which contains tannin, and may therefore be called the tannin-layer. The cells of this tissue are mostly arranged radially. 2. The protective layer, Frank's "Schutzschicht" and Lacaze-Duthier's "couche protectrice," which most often consists of sclereids. 3. The inner or nutritive layer, Lacaze-Duthier's "couche alimentaire," which is composed of thin-walled parenchyma, the cells of which are frequently provided with large pores. This tissue contains an emulsion of oil, sugar and albumen; it is often very loose and shows large intercellular spaces. These layers are, however, not observable in all forms of galls; they are, according to the author, especially characteristic of the cynips-gall.

But if we consider galls in general, the author makes the following statements: 1. Vegetable tissues become developed, which enclose the animal embryos or fungus spores; or else the existing tissues become utilized for the enclosure or covering of these embryos or spores. 2. These tissues develop a nutritive layer.

The nutritive layer develops from its inner epidermis roundish sacs or long papillose hairs, or the cells may possess only pores, through which the nutritive materials can pass and become utilized by the larva. It would appear that vegetable galls might be produced artificially with the same success as has been done with the common fresh water mussel, where the introduction of a mustard seed developed a pearl. This does not seem to be the case, however, according to numerous experiments made by the author. The following substances were tried on plants: formic acid, acetic acid, tincture of cantharides, croton oil, mustard oil, lactic acid, potassium iodide, iodine, lead acetate, suet, albumen, yeast, and sugar. The injections were made by means of a horn pin, with which the author punctured the midrib of leaves or young shoots, and subsequently introduced the solutions through capillary glass tubes. He finally introduced a small piece of black mustard seed and covered the opening with court plaster. The result was, however, negative in all instances. Similar experiments have also been made by Beyerinck,[6] who inoculated young leaves of *Salix purpurea* with the contents of the vesicle of *Nematus viminalis*, but without being able to produce the corresponding nematus-gall. One result was gained, however, which also confirms the correctness of Beyerinck's observations, viz., that neither the puncture itself nor the irritation which it causes to the plant is the real cause of the development of the gall, but that the larva of the animal or the fungus spore is the factor which produces the gall. It is, therefore, not difficult to prevent the development of a gall, and this can be done by killing the larva before the gall has reached its full size.

The author gives the history of the development of a number of galls from various species of wild roses, oaks, etc., and a systematic classification of the galls. This classification depends upon whether the galls are free or immersed in the plant; whether they contain one or more embryos; and according to the host, whether this belongs to the angiosperms, the conifers or the ferns. The occurrence of tannin in the galls is discussed at length, and there are many other points of interest in the work, so that it forms a welcome contribution to the study of vegetable galls in general.—THEO. HOLM.

The combined effects of geotropism and heliotropism.[7]

Dr. Czapek has recently obtained some valuable conclusions as to the interlocking effect of light and gravity stimuli. He finds that plants which are placed horizontally (for 60–70 minutes) until they have begun an upward geotropic curvature, when placed in an erect position and given a light stimulus on the previously lower side, will react to the light in exactly the same time as a control plant which has been standing upright meanwhile. On the other hand plants which were first given a heliotropic stimulus were greatly delayed in their reactions to a geotropic stimulus given later in an opposite direction. In the extension of the experiments plants were subjected to these two stimuli in every position from

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[6] Beyerinck, M. W.: Beobachtungen über die ersten Entwickelungsphasen einiger Cynipidengallen. Amsterdam 1882. Also: Ueber das Cecidium von *Nematus Capreæ* auf *Salix amygdalina*. Bot. Zeit. **46:** 1–11.17–28. 1888.

[7] F. Czapek, Ueber Zusammenwirken von Heliotropismus und Geotropismus. Aus d. Sitzungsber, d. kaiserl. Akademie d. Wiss. i. Wien. math.-naturw. Classe **4**[1]:—. Mr 1895.